Carnatic Raga Identification using Arohana-avarohana Pattern

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ABSTRACT

Raga is a melodic framework for Indian classical music; it is a complex system consisting of notes, scales, and pitches. Raga mining is the technique of identifying the Raga of a song. Ragas can be distinguished from one another by their sequence of notes, melody, and its rendition. Identifying the Raga of a song can be challenging for beginners and non-musicians. Identifying the Raga can help learners classify songs to their corresponding Raga. This paper proposes the method of identifying the Raga by its Arohana-avarohana pattern. Arohana-avarohana pattern is the arrangement of notes occurring in the song ascending and descending order. The input is taken in the form of .wav file. The system converts the song into a file buffer. File buffer contains the information of the audio. This file buffer can be used to divide the song into segments, of 5 seconds and extract the notes in the segments. This is done using the Aubio library. The extracted notes are matched against the Arohana-avarohana pattern of the Ragas. The estimation of Raga is done based on the scoring method. For each note found, and matched against a Raga, the score for that Raga is incremented. The final Raga is found to be the Raga having the maximum score. This system was tested for various audio recordings of classical music and movie songs for the corresponding Raga. Two Ragas- Hindolam and Anandabhairavi are identified with an accuracy of 87%.

Keyword - *Raga, Arohana-avarohana pattern, notes, pattern matching.*

1. INTRODUCTION

Carnatic music is also known as the classical music of southern India. It is said to be originated in Karnataka, hence the name Carnatic music. Carnatic music history says that the swaras (also known as notes in Indian music) were originated from the sounds of birds and animals. And like some other forms of Indian music, the Carnatic compositions are sung in 3 to 7 notes.

The Sampoorna ragas in Carnatic music consists of all seven notes and are classified in a system called the Melakarta as per the kinds of notes in a composition. In total, there are 72 melakarta ragas. The seven notes of Carnatic music are Sa (Shadja) Ri (Rishaba) Ga (Gandhara) Ma (Madhyama) Pa (Panchama) Da (Daivatha) Ni (Nisadha). There are 12 swarasthanas in Carnatic music. There is shruthi and raga in Carnatic music.

The different combinations of Swaras with adherence to specific rules make up the seventy-two Melakartha ragas. Each raga is composed of defined notes and depicts a specific mood. There are attributes related to each raga that enhances its feel and emotions. Some of these attributes are Arohana and Avarohana, Gamaka, Vadi, Samavadi, Tala and Samay. Arohana is the sequence of swaras used in a raga in the ascending passages i.e., as the pitch goes up. Avarohana is the sequence of swaras to be used in descent. The arohana and avarohana (or the scale) of a raga provide only emaciated outline upon which the rest of the raga is formed.

Shruthi

Shruthi, which refers to the foundational pitch or frequency. Foundational musical note is called the Shajama (or Shadja) which is sung as ‘Sa’ in short. One of the technically sound definitions of Shruti is that it refers to musical positions which are a certain distance away from the starting frequency, which is called Tonic. There are different shruthi selected based on the tonic range of the performer.

Raga

A Raga in the simplest form is a melody made up of a specific sequence of notes rendered with certain characteristic ornamentations (gamakas) and intonations.

Raga (also known as ragam in Carnatic music) is a melody which is created with notes or swaras. These swaras are arranged in ascending and descending order. Ascending order is called Arohana, and the descending order is called Avarohana. For a raga to be complete, there should be at least5 notes in ascending and 5 notes in descending order.The simplest way to classify ragas is by the number of swaras it has.

Melakarta ragas/parent ragas–a raga which incorporates all the 7 swaras in a systematic sequence order is called a melakarta raga. There are no jumps or zigzags in the swaras.

Janya Ragas – 'Janya' means that which has taken birth from. Janya ragas are ragas which are derived from Janaka ragas (Parent – Melakarta ragas). They may have less than 7 notes in their scales, or have additional notes in them.

Vakra Ragas – Vakra Ragas are also forms of janya ragas, that is, they are derived from the janak-melakarta ragas. However, their characteristic feature is that their swaras are not arranged in the original sequence. They are arranged in a zigzag manner.

2. LITERATURE SURVEY

Vijay Kumar and team [1] proposed a method to identify the ragas of an Indian Carnatic music signal. This has several interesting applications in digital music indexing, recommendation, and retrieval. However, this problem is hard due to (i) the absence of a fixed frequency for a note (ii) relative scale of notes (iii) oscillations around a note, and (iv) improvisations.

In this work, they have attempted the raga classification problem using a non-linear SVM and a combination of two different kernels. They introduce the kernels to suit the Indian Carnatic music that represents the similarities of a raga based on pitch-class profile and n-gram note distribution. This differs from the previous pitch-class profile based approaches where the temporal information of notes is ignored. Given a music piece, they initially extract the predominant pitch values at every instant of time, convert to cents scale, map them to single octave and identify the stable note regions. These notes are then used to construct Pitch-class profile and n-gram distribution.

Gulati and team [2] proposed a system Automatic raga recognition. Motivated by the way seasoned listeners identify ragas, they proposed a raga recognition approach based on melodic phrases. Firstly, they extracted melodic patterns from a collection of audio recordings in an unsupervised way. Next, they group similar patterns by exploiting complex networks concepts and techniques. Drawing an analogy to topic modeling in text classification, they then represent audio recordings using a vector space model. Finally, they employ several classification strategies to build a predictive model for raga recognition.

Shreyas Belle and team [3] proposed a system where they investigated information pertaining to the intonation of swaras (scale-degrees) in Hindustani Classical Music for automatically identifying ragas. They looked at two approaches by other authors that exploit some of these characteristics. Then review musicological studies that mention intonation variability of swaras across ragas, providing a basis for using swara intonation information in raga recognition. Features derived from swara intonation are used in a statistical classification framework to classify audio segments corresponding to different ragas with the same swaras.

Surendra Shetty , K.K. Achary, and team [4] used a data mining model. Raga mining is a part of data mining where audio data is considered in specific. Their system takes an audio file as an input and converts it into sequence of notes, identifies the raga by extracting its Arohana-avarohana pattern.

Pranay Dighe and team [5] attempted towards robust automated analysis of Indian classical ragas through machine learning and signal processing tools and techniques. They developed methods to perform scale-independent raga identification using a random forest classifier on swara histograms and achieved state-of-the-art results for the same. The approach is robust as it directly works on partly noisy raga recordings from YouTube videos without knowledge of the scale used, whereas previous work in this direction often uses audios generated in a controlled environment with the desired scale.

3. PROPOSED SYSTEM

In this section, we introduce the onset detection method, signal preprocessing techniques, and discuss the pattern matching method and later revisit the scoring method.

The song is processed as an array buffer. This buffer contains information of the song, such as its characteristics. The song is processed in small frames of 1024 bytes, this process is called Sampling. Sampling is done to achieve a higher accuracy in listing of the notes in a song.
The architecture diagram for the proposed system is given in Fig.1

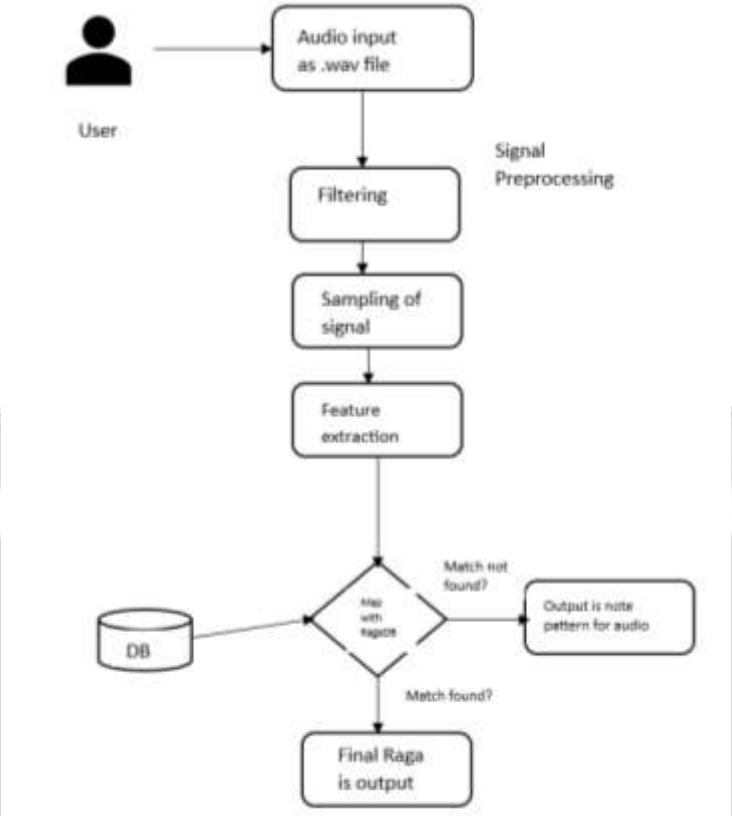

Fig-1 Architecture Design of proposed system

3.1 Onset Detection

Note detection is the process of detecting the pitch or frequency of individual musical notes in an audio. It is an important task in music information retrieval and can be used in a variety of applications.

The working of note detection is by analyzing spectral content of audio and identifying the frequency corresponding to the notes for each sample. In our system, we use the Aubio library for note detection.

The standard Onset detection algorithm used by Aubio is the Spectral Difference(SpecDiff) algorithm. This algorithm computes the difference between the magnitude spectra of successive frames and detects onsets where there is a significant change in spectrum.

The SpecDiff algorithm works by computing the short-term power spectrum of the audio using the Fast Fourier Transform (FFT). It then calculates the difference between successive spectra and applies a smoothing function to the resulting difference signal. Onset is detected when the smoothened signal exceeds a certain threshold.

3.2 Signal Preprocessing

Signal Preprocessing is the process of preparing the audio for further analysis. It involves a series of operations that are applied to the raw audio to enhance its quality and extract relevant features. Some of the techniques used in our system is –

i. Filtering – It is the process of removing unwanted frequency components from the audio signal.

ii. Sampling – It is the process of fragmenting the audio sample into several different frames that can be processed in the later stages.

iii. Feature extraction – It is the process of extracting relevant features, in our system, the notes, or swaras.

3.3 Pattern matching method

Pattern matching is a method used in signal processing to find patterns and similarities between signals. It involves comparing the target signal to one or more reference patterns and identifying the areas where the target signal matches the reference pattern.

Our system uses the pattern matching system to match the swaras obtained in the signal preprocessing step and compares it against the predefined set of notes for each raga, which is the Arohana-avarohana pattern. The system prints the notes, or swaras in the audio for which the raga is not identified, so that the user can search for the raga by using the extracted notes and identify the raga.

3.4 Scoring Method

The scoring method is a way of quantifying the similarity between the target signal and the reference pattern. This method is used to evaluate the performance of the system and to find the final raga. The scoring method employed in our system calculates the Euclidean distance between the target signal and the pattern. For each matched reference pattern and the swara pattern obtained, the score for the corresponding raga is incremented. The final raga is the raga that has the highest score. Fig.2 gives the score for the raga, and final raga is the raga having highest score.

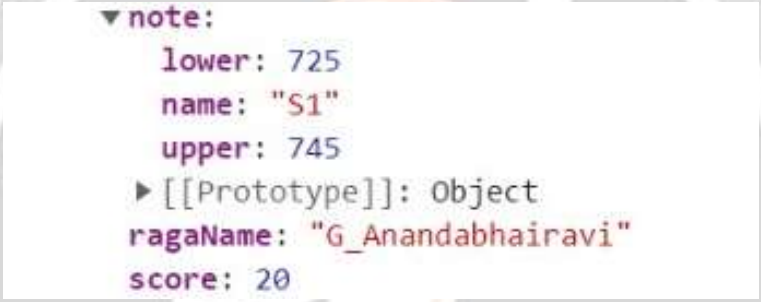

Fig-2 Scoring method employed for raga mining which has identified the raga of the audio to be raga 'Anandabhairavi'

From the fig. we see that the raga 'Anandabhairavi' is having highest score, hence it is the final output.
The algorithm for pattern matching and scoring method can be formulated as-

Algorithm Pattern Matching and Scoring
1: **procedure** PatternMatchingandScoring(notes)
2: Import the notes detected.
3: **for all** notes in song **do**
4: Check the arohana-avarohana pattern.
5: Match the notes with the given arohana-avarohana pattern.
6: **if** notes and the pattern for a raga match
7: increment the score for the raga.
8: // Get highest score for a raga
9: **end for**
10: Final raga is the raga having the highest score
11: **end procedure**

4. RESULTS AND DISCUSSIONS

The system works with an accuracy of 87% for two ragas – Hindolam and Anandabhairavi. The system was checked for its accuracy with over 50 songs and for more than 43 songs we have obtained promising results. The system can

be explored for more ragas and songs. The system can also be made to work for both forms of Indian classical music. The system to work for both forms of Indian music, will require to consider other parameters and characteristics of the Raga, as both forms include varied characteristics for a raga.

5. CONCLUSIONS

The field of raga mining has seen significant progress in recent years, with the development of new techniques and tools for analyzing audio signals and extracting meaningful information. Some of the key approaches used in raga mining include signal processing, machine learning, and pattern recognition. One of the major challenges in raga mining is dealing with the complexity and variability of Indian classical music, which involves many different ragas, each with its own unique characteristics and variations. Another challenge is the lack of annotated data and standardized notations, which makes it difficult to compare and analyze different recordings.

This project was developed with an aim to aid budding musicians and music enthusiasts in recognizing the raga of a Carnatic song. The system works accurately for polyphonic audio. The scope of this paper can be expanded to work for many ragas and songs.

6. REFERENCES

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